Mechanics and Motion

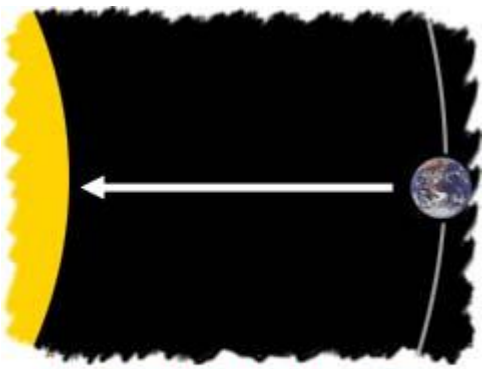
Motion is one of the key topics in physics. Everything in the universe moves. It might only be a small amount of movement and very very slow, but movement does happen. Don't forget that even if you appear to be standing still, the Earth is moving around the Sun, and the Sun is moving around our galaxy. The movement never stops. Motion is one part of what physicists call mechanics.

Speed it Up, Slow it Down

The physics of motion is all about forces. Forces need to act upon an object to get it moving, or to change its motion. Changes in motion won't just happen on their own. So how is all of this motion measured? Physicists use some basic terms when they look at motion. How fast an object moves, its speed or Velocity, can be influenced by forces. (Note: Even though the terms 'speed' and 'velocity' are often used at the same time, they actually have different meanings.)

Acceleration is a twist on the idea of velocity. Acceleration is a measure of how much the velocity of an object changes in a certain time (usually in one second). Velocities could either increase or decrease over time. Mass is another big idea in motion. Mass is the amount of something there is, and is measured in grams (or kilograms). A car has a greater mass than a baseball.

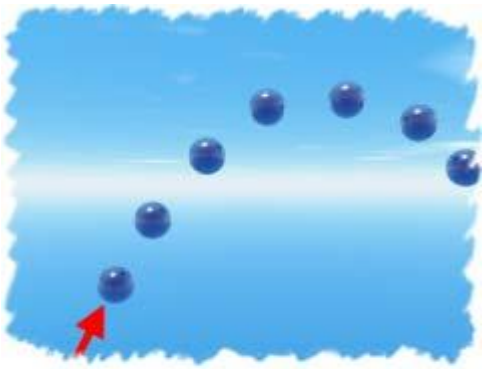
Forces of Nature



Forces are a big part of physics. Physicists devote a lot of time to the study of **forces** that are found everywhere in the universe. The forces could be big, such as the pull of a star on a planet. The forces could also be very small, such as the pull of a nucleus on an electron. Forces are acting everywhere in the universe at all times.

Examples of Force

If you were a ball sitting on a field and someone kicked you, a force would have acted on you. As a result, you would go bouncing down the field. There are often many forces at work. Physicists might not study them all at the same time, but even if you were standing in one place, you would have many forces acting on you. Those forces would include gravity, the force of air particles hitting your body from all directions (as well as from wind), and the force being exerted by the ground (called the **normal force**).

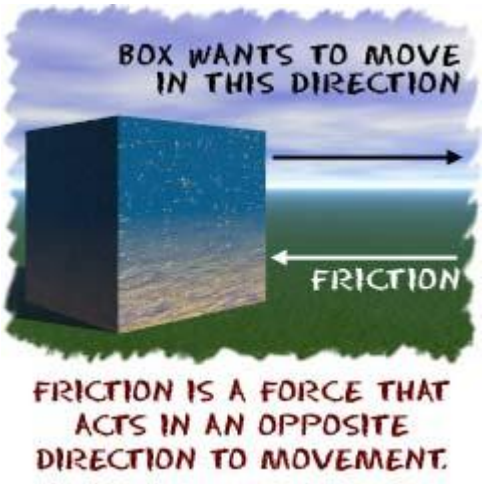


Let's look at the forces acting on that soccer ball before you kicked it. As it sat there, the force of gravity was keeping it on the ground, while the ground pushed upward, supporting the ball. On a molecular level, the surface of the ball was holding itself together as the gas inside of the ball tried to escape. There may have also been small forces trying to push it as the wind blew. Those forces were too small to get it rolling, but they were there. And you never know what was under the ball. Maybe an insect was stuck under the ball trying to push it up. That's another force to consider.

If there is more than one force acting on an object, the forces can be added up if they act in the same direction, or subtracted if they act in opposition. Scientists measure forces in units called **Newtons**. When you start doing physics problems in class, you may read that the force applied to the soccer ball (from the kick) could be equal to 12 Newtons.

Friction Basics

Friction is a force that holds back the movement of a sliding object. That's it. Friction is just that simple.



You will find friction everywhere that objects come into contact with each other. The force acts in the **opposite** direction to the way an object wants to slide. If a car needs to stop at a stop sign, it slows because of the friction between the brakes and the wheels. If you run down the sidewalk and stop quickly, you can stop because of the friction between your shoes and the cement.

What happens if you run down the sidewalk and you try to stop on a puddle? Friction is still there, but the liquid makes the surfaces smoother and the friction a lot less. Less friction means it is harder to stop. The low friction thing happens to cars when it rains. That's why there are often so many accidents. Even though the friction of the brakes is still there, the brakes may be wet, and the wheels are not in as much contact with the ground. Cars **hydroplane** when they go too fast on puddles of water.

Friction and Gases

Friction only happens with solid objects, but you do get **resistance** to motion in both liquids and gases. This doesn't involve sliding surfaces like friction does, but is instead the kind of resistance you get if you try to push your way through a crowd. It's a colliding situation, not a sliding one. If the gas is air, this is referred to as **air resistance**.

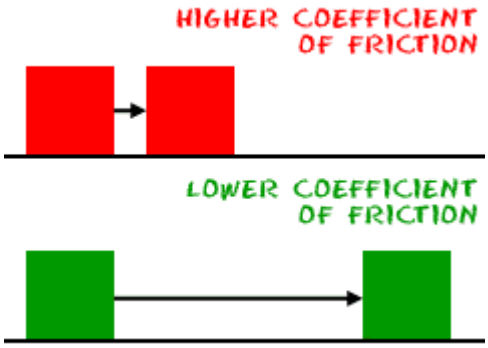
If you were in the space shuttle and re-entering the atmosphere, the bottom of the shuttle would be getting very hot. The collisions that occur between the molecules of the air being compressed by the shuttle, heat up the air AND the shuttle itself. The temperature on the top of the shuttle is also warm, but nowhere near the temperatures

found on the bottom.

Friction and Liquids

Although liquids offer resistance to objects moving through them, they also smooth surfaces and reduce friction. Liquids tend to get thinner (less **viscous**) as they are heated. Yes, that's like the viscosity of the oil you put in your car. Car engines have a lot of moving parts, and they rub on each other. The rubbing produces friction and the result is heat. When oil is added to a car engine, the oil sticks to surfaces, and helps to decrease the amount of friction and wear on the parts of the engine. An engine that runs hotter requires a more viscous oil in order for it to stick to the surfaces properly.

Measuring Friction



Measures of friction are based on the type of materials that are in contact. Concrete on concrete has a very high **coefficient of friction**. That coefficient is a measure of how easily one object moves in relationship to another. When you have a high coefficient of friction, you have a lot of friction between the materials. Concrete on concrete has a very high coefficient, and Teflon on most things has a very low coefficient. **Teflon** is used on surfaces where we don't want things to stick; such as pots and pans.

Scientists have discovered that there is even less friction in your joints than in Teflon! It is one more example at how efficient living organisms can be.

Forces of Attraction

Gravity or **gravitational forces** are forces of attraction. We're not talking about finding someone really cute and adorable. It's like the Earth pulling on you and keeping you on the ground. That pull is gravity at work.

Every object in the universe that has **mass** exerts a gravitational pull, or force, on every other mass. The size of the pull depends on the masses of the objects. You exert a gravitational force on the people around you, but that force isn't very strong, since people aren't very massive. When you look at really large masses, like the Earth and Moon, the gravitational pull becomes very impressive. The gravitational force between the Earth and the molecules of gas in the atmosphere is strong enough to hold the atmosphere close to our surface. Smaller planets, that have less mass, may not be able to hold an atmosphere.